Health-Related Problems and Changes After 1 Year as Assessed With the Geriatric ICF Core Set (GeriatrICS) in Community-Living Older Adults Who Are Frail Receiving Person-Centered and Integrated Care From Embrace

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Running head: GeriatrICS assessment in frail elderly

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Declaration of interests

We certify that no party having a direct interest in the results of the research supporting this article has or will confer a benefit on us or on any organization with which we are associated and we certify that all financial support for this research and work are clearly identified in the title page of the manuscript.

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Health-related problems and changes after one year as assessed with the Geriatric ICF Core Set (GeriatrICS) in community-dwelling frail older adults receiving person-centred and integrated care from Embrace

Abstract

Objective: To assess the prevalence, severity and change in health-related problems in a sample of older adults who received individual care and support from Embrace, for the whole sample, per subgroup based on complexity of care needs and frailty, and for those who had at baseline a health-related problem.

Design: A pretest-posttest study with assessments at baseline and after twelve months.

Setting: Community.

Participants: Older adults aged 75+ who are frail (n=56) or with complex care needs (n=80).

Intervention: Participants received care and support by Embrace, a person-centred and integrated care service for community-living older adults supporting them to age in place. A multidisciplinary team provided care and support, with intensity depending on the older adults' risk profile.

Main outcome measure: Health-related problems as perceived by older adults and measured with the Geriatric ICF Core Set (GeriatrICS).

Results: Health-related problems were related to six coherent clusters: 'Mental Functions', 'Physical Health', 'Mobility', 'Personal Care', 'Nutrition' and 'Support'. The most prevalent and most severe problems at baseline were related to Mental Functions and Mobility. Changes in the prevalence of problems after twelve months varied. Severity scores decreased or remained stable, except for Mobility items which showed a varying changing pattern in participants with complex care needs. Prevalence and severity of problems for those with a problem at baseline decreased after twelve months. Frail participants with a problem had higher baseline severity scores than those with

complex care needs experiencing a problem, but differences in changes between frail individuals and those with complex care needs were small.

Conclusions: The results are encouraging and may indicate that individual, person-centred and integrated care and support from Embrace offers a route to counteracting the decline in physical, cognitive and social functioning associated with ageing.

Keywords

Functioning; health; disability; ICF; ageing; chronic care model; integrated care; person-centred care; community-dwelling; older adults

List of abbreviations

CCM = Chronic Care Model

GeriatrICS = Geriatric ICF Core Set

GFI = Groningen Frailty Indicator

GP = general practitioner

ICF = International Classification of Functioning, Disability and Health

INTERMED-E-SA = INTERMED for the Elderly Self-Assessment

WHO = World Health Organization

Worldwide, current healthcare systems are insufficiently well equipped to provide appropriate care and support to older adults with healthcare needs [1]. Up to two-thirds of the global population aged 75 and older suffers from multimorbidity [1-4]. These individuals present a wide variety of health-related problems [5, 6], with great variability in health and health-related functional ability [7-9]. However, healthcare systems focus on treating single diseases. This results in inefficient, ineffective and fragmented care for this growing older population [10, 11] – and consequently misunderstanding by the patient, low treatment participation and even treatment errors [12, 13]. Therefore, these healthcare systems have to deal with the complexity of treating multimorbidity and the changing and diverse healthcare needs of older adults, which calls for a worldwide system change [10, 11, 14, 15].

Person-centred and integrated care services could encourage comprehensive care for older adults [11], as acknowledged by the European Union [16], the World Health Organization (WHO) [14, 15] and older adults themselves [17]. According to the WHO, person-centred care is 'organized around the health needs and expectations of people rather than diseases'. Integrated care services provide a continuum of care and support and address the needs of the individual [15].

An example of such a new person-centred and integrated care service for older adults is 'Embrace' [18]. Embrace is based on the increasingly popular Chronic Care Model (CCM) [19, 20], which integrates community resources with healthcare services, and the Kaiser Permanente triangle [21], a Population Health Management model which segments the population into risk profiles. The aim of Embrace is to prolong ageing in place by addressing the needs of the individual older adult living in the community. A multidisciplinary Elderly Care Team organises person-centred care and support in consultation with the older adults. The focus and intensity of this care depends on a person's risk profile, which is based on the self-reported complexity of care needs and level of frailty ('Complex care needs', 'Frail', 'Robust'). Embrace has been implemented extensively in the North of the Netherlands. The effectiveness of the original Embrace study regarding patient outcomes,

service use, costs and quality of care was investigated in a randomized controlled trial [18, 22, 23]. The current study was embedded in that trial.

As the impact of ageing on health and functioning differs between individuals [24, 25], insight into the health-related problems and accompanying needs of the individual older adult is needed to guide the delivery of person-centred and integrated care and support. The Geriatric ICF Core Set (GeriatrICS) has been developed to provide such insight. It reflects the most relevant health-related problems of community-dwelling older adults without a dementia diagnosis and is based on the International Classification of Functioning, Disability and Health (ICF) [26]. Within Embrace, the GeriatrICS was used for history taking from frail older adults and those with complex care needs receiving individual care and support by a case manager. Based on this history, care and support was adapted to the needs of the older adult. Follow-up evaluations using the GeriatrICS were performed to assess whether problems were solved or to identify newly arisen problems.

Therefore, the first objective of this study was to assess the prevalence and severity of health-related problems and the change after receiving individual care and support from 'Embrace' for the whole sample and for subgroups based on the risk profiles 'Frail' and 'Complex care needs'. The second objective was to assess the above for those who had a health-related problem at baseline as a consequence of ageing.

Methods

Study design

We conducted a twelve-month single-group pretest-posttest study on a group of older adults aged 75 and older who were allocated to the intervention group of a randomized controlled trial on the effectiveness of the person-centred and integrated care service 'Embrace' [18]. The study had been registered in the Netherlands National Trial Register (NTR3039, http://www.trialregister.nl). The Medical Ethical Committee of the University Medical Center Groningen assessed the Embrace study proposal, including the analyses as reported here, and concluded that approval was not required (Reference METc2011.108). The STROBE-guidelines are used for reporting in this paper [27]. All participants provided written informed consent prior to the start of the Embrace study.

Sample

This pretest-posttest study examined a subsample of participants from the Embrace study receiving individual care and support and classified in the risk profiles 'Complex care needs' and 'Frail'. Embrace included people aged 75 and older who were registered with a participating general practitioner (GP) (n=1456, response rate 48.7%). Participants were classified into three risk profiles using their level of complexity of care needs – as measured with the INTERMED for the Elderly Self-Assessment (INTERMED-E-SA) [28] – and the level of frailty – as measured with the Groningen Frailty Indicator (GFI) [29, 30]. The resulting risk profiles are: 'Complex care needs' for participants with complex care needs at risk for assignment to a hospital or nursing home (INTERMED-E-SA ≥16), 'Frail' for participants at risk of complex care needs (INTERMED-E-SA <16 and a GFI ≥5) and 'Robust' for participants at risk for the consequences of ageing (INTERMED-E-SA <16 and GFI <5). Participants were then randomized into the control or intervention groups. A more detailed description of the Embrace study has been published elsewhere [18].

Those identified as frail or having complex care needs, who had been assigned to the intervention group of the Embrace study and who had completed baseline history-taking with the

GeriatrICS [26] within six months of the start were eligible for the current study. Actual inclusion comprised those who completed follow-up assessments twelve months after baseline assessment.

Embrace

Embrace is a person-centred and integrated care service for community-dwelling older adults, which has been implemented in the North of the Netherlands. A multidisciplinary Elderly Care Team consisting of a GP, a nursing home physician [31] and two case managers – a district nurse and a social worker for the participants with complex care needs and frail participants, respectively – organised care and support for older adults. The intensity, focus and individual or group approach of care and support depended on the participant's risk profile. Frail people and those with complex care needs received individual support from a case manager. The participant and case manager jointly developed an individual care and support plan which targeted all health-related problems identified during history taking using the GeriatrICS [26]. Case managers organised the care and support as decided on in the care and support plan. They monitored changes and navigated the plan's delivery. Participants were also invited to follow a self-management support and prevention programme – including regular Embrace community meetings – which focused on staying healthy and independent for as long as possible. Details of the implementation of Embrace have been published in the study protocol [18].

Data collection and procedure

Data for this study were collected at baseline (T0: January-June 2012) and after twelve months (T1: January-June 2013). Baseline assessments were performed during home visits. During these visits, case managers took a history using the GeriatrICS [26], which was integrated into the web-based electronic record system of Embrace. Follow-up assessments were performed either by the relevant case manager or by the participant completing a mailed, paper version of the GeriatrICS him or herself once individual care and support had ended. Self-report questionnaires from the Embrace

study (October-December 2011) provided data for assignment to the risk profiles at start, as well as data on background characteristics.

Assessment tool

Health-related problems were evaluated using the GeriatrICS, a validated ICF Core Set for community-dwelling older adults without dementia which includes 29 items covering fourteen Body Functions, nine Activities and Participation, and six Environmental Factor categories [26]. During the assessment, participants had to indicate whether they experienced problems in functioning and whether they experienced lack of support in relation to the Environmental Factors items. Participants had to rate all the items on a visual analogue scale ranging from 0 (no problem) to 10 (very severe problem). In the paper version of the GeriatrICS, each ICF item from the GeriatrICS was translated into a single question.

Analysis

We first examined baseline data and changes per ICF item for the whole sample and for the subgroups 'Complex care needs' and 'Frail' (Objective 1). We analysed responses in terms of whether or not a health-related problem existed (prevalence) and in terms of its severity. Prevalence scores were dichotomized scores including 'no problem' (score 0) versus 'problem' (scores 1-10), while severity scores employed the full 0-10 range. Differences in prevalence between the subgroups ('Complex care needs' and 'Frail') at baseline were tested using difference of proportions tests and Mann-Whitney U tests to assess differences in severity. Changes in prevalence after twelve months were analysed using McNemar's tests. Changes in severity were analysed by Wilcoxon signed rank tests. We considered changes to be statistically significant at $p<0.05$ (two-tailed; $p<0.0017$ after Bonferroni correction). We calculated Cohen's *d* effect sizes to measure the strength of the effect.

We then repeated all analyses for each ICF item, including only those older adults who reported a health-related problem with that item at baseline (Objective 2). We analysed using SPSS Statistics version 22.0 and calculated effect sizes using Microsoft Excel 2010.

Results

The flow of participants is presented in Figure 1. Of the 267 eligible participants, 136 (50.9%) were included in this study because they completed follow-up assessments. Participants mainly dropped out because of a missing end evaluation when a participant was transferred to the Robust profile (48.9%), due to death (13.7%), termination of participation (6.9%), moving to another living situation or city (9.2%) or for unknown reasons (19.8%). No statistically significant differences in the baseline characteristics and ICF severity scores were found between those included and those lost to follow-up, except for dropouts scoring worse than participants on 'experienced health today' (EQ-VAS p=0.013) but better than participants on *b152 Emotional functions* (p=0.024) and *b710 Mobility* (p=0.035).

Figure 1

Table 1

In general, the health-related problems reported by older adults were pragmatically and retrospectively grouped into six coherent clusters: 'Mental Functions', 'Physical Health', 'Mobility', 'Personal Care', 'Nutrition' and 'Support' (see Table 2).

Table 2

All older adults in this study

Table 3 provides an overview of the prevalence of the problems reported at baseline, the severity and change in their prevalence, and the severity in the whole sample. The most prevalent and most severe problems at baseline were related to Mental Functions (*b152 Emotional functions*) and Mobility.

The changes in prevalence after twelve months varied. The largest decreases were found for items related to Mental Functions (*b152 Emotional functions*), Nutrition (*d560 Drinking*) and Support (*e575 General social support services, systems and policies*), whereas the prevalence of the Mobility-related items increased (*b730 Muscle power functions*). Severity scores decreased or remained stable after twelve months.

'Complex care needs' vs 'Frail' individuals

Baseline differences between subgroups were noticeable, as participants with complex care needs had higher prevalence and severity scores compared to frail participants regarding Personal Care items (Table 3). Frail participants, on the other hand, had higher baseline severity scores on Mental Functions (*b144 Memory functions*) and Physical Health (*b230 Hearing functions*).

Participants with complex care needs had varying alterations in prevalence after twelve months. Severity scores, however, mainly remained stable or decreased, except for the Mobility items which showed a more varying pattern. Frail participants also showed varying alterations in prevalence, but the severity in all clusters decreased or remained stable after twelve months.

Table 3

Older adults with problems at baseline

Table 4 shows the number of older adults experiencing a problem at baseline, their baseline severity scores and the changes in number of participants who still had a problem at follow-up, as well as the related severity scores. Testing the change in prevalence per ICF item could not be performed in this

case, given that at baseline (T0) 100% of the older adults had a health-related problem with that ICF item. The baseline severity scores of those with a problem at baseline were highest for Mental Functions and Mobility.

Participants with a problem at baseline generally showed clear positive changes after twelve months. The largest reductions in the number of participants with persistent problems were in items related to Personal Care, Nutrition and Support (could not be statistically tested). Severity scores decreased for all items, with the largest decreases (effect sizes) being related to Nutrition and Support.

'Complex care needs' vs 'Frail' individuals

Comparing the subgroups of participants with a problem at baseline showed similar, positively changing patterns in prevalence and severity, but baseline severity scores were higher for frail participants than for those with complex care needs (Table 4).

For both subgroups, the numbers of participants who still had a problem at follow-up decreased, with the largest decreases in items related to Personal Care, Nutrition and Support (could not be statistically tested). Severity scores decreased for almost all items after twelve months, with the largest decreases (effect sizes) being related to Nutrition and Support.

Table 4

Discussion

This is the first study which used the GeriatrICS to obtain detailed insight into the prevalence, severity and changes in perceived health-related problems of community-dwelling older adults who received twelve months of individual, person-centred and integrated care and support. We grouped health-related problems reported by older adults into six clusters: 'Mental Functions', 'Physical Health', 'Mobility', 'Personal Care', 'Nutrition' and 'Support'. The most prevalent and most severe

problems at baseline were related to Mental Functions and Mobility. The changes in prevalence after twelve months varied, with largest decreases found in the clusters Mental Functions, Nutrition and Support, whereas the prevalence of Mobility-items increased. Overall, severity scores decreased or remained stable. This picture was also present in both risk profiles, except for a more varying pattern in severity scores of Mobility-items in participants with complex care needs. For those with a problem at baseline, the prevalence and severity of these problems decreased in all clusters after twelve months. Furthermore, of those reporting a problem at baseline, frail participants reported higher severity scores than participants with complex care needs.

Mobility-related problems were the most frequent and severe problems and showed a varying change pattern. This was especially the case for older adults with complex care needs. Mobility is known to constitute an important condition for independent living which often deteriorates during ageing. It is also a strong indicator of functional decline, health status and frailty [32, 33]. Older adults were perhaps not sufficiently exposed to lifestyle interventions, such as physical exercise training or dietary adaptations, or encouraged to participate during the twelve months. Such lifestyle interventions could prevent or solve mobility problems [32, 34]. Therefore, case managers and other health care and welfare professionals should pay extra attention to the possible preventive effect of such interventions for older adults.

Frail participants with a problem had higher baseline severity scores than participants with complex care needs experiencing a problem. However, both groups showed positively changing patterns after twelve months of person-centred and integrated care and support. The fact that frail participants had higher baseline severity scores is counterintuitive, as those with complex care needs usually have a poorer clinical condition. This might be because this latter group may already have become accustomed to the consequences of ageing and able to apply coping strategies for health problems, whereas frail older adults still have to adapt to and accept the consequences of ageing [35, 36]. Professionals should therefore consider the duration of the problems experienced in

supporting older adults. Those with relatively 'new' problems may have more difficulty with coping, whereas those with persistent problems may already have adapted to some extent to their situation.

The improvements after twelve months are encouraging, since normal ageing is associated with decreased physical, cognitive and social functioning [32, 37, 38]. The participants may have learned about the consequences of ageing and care and support available, as communicated by case managers and as acquired during Embrace community meetings [18]. This may have strengthened their self-management abilities and coping strategies, and thus their well-being [39, 40]. Care and support for older adults should therefore stimulate self-management and coping behaviour, for example by arranging adjustments at home and the acquisition of aids.

Strengths and limitations

The main strength of this study was the use of the GeriatrICS, a broad scoped ICF Core Set including the most relevant health-related problems of community-dwelling older adults. ICF Core Sets can be a useful tool for problem assessment, goal setting and evaluation in rehabilitation management [41]. A minority of the recently developed Core Sets has been used for evaluation of change [42-46]. The GeriatrICS provided insight into the differences between frail participants and participants with complex care needs.

However, the results should be interpreted while taking some of the limitations of this study into account. First, the potential for causal inferences based on the results is limited as this was a pretest-posttest study with no control group, due to the fact that the GeriatrICS was not administered in the control group of the original trial [47]. Second, the health-related problems of older adults were pragmatically and retrospectively grouped into six coherent clusters. However, the clusters were comparable to the components of current geriatric assessment tools [48-52], supporting the clustering. Also, we made quite many comparisons, which may have caused findings to be spuriously significant [53]. Furthermore, as we used a real life sample in this study, we may have to deal with selection bias as a result of a relatively high dropout rate. Dropouts were due to a

positive event, e.g. a participant being transferred to the Robust profile, or due to a negative event, e.g. death of a participant or transfer to a nursing home. In both situations, the case manager could not, or did not, perform an end evaluation – which reflects the real-life situation in health care. As a consequence, these participants dropped out of our sample for analyses. However, there were only small differences between respondents and dropouts concerning baseline characteristics. Finally, the method of classification of participants into risk profiles may have affected findings. We used two self-reported, multidimensional instruments measuring frailty and complexity of care needs from a broad perspective. Other frailty instruments may have led to different risk profiles [54].

Implications

The GeriatrICS can be used to identify health-related problems in older adults and to provide person-centred and integrated care and support. We found that mobility problems were frequent and hard to counteract. The prevention of mobility problems remains challenging [34]. In addition, the improvements after twelve months may indicate that the self-management abilities and coping strategies of older adults were strengthened. Coping is therefore an issue on which case managers and caregivers should focus. Proactive coping in particular (being future-oriented) may be a good way to deal with the consequences of ageing, besides maintenance of meaningful activities and relationships [55].

We found improvements in the prevalence and severity of health-related problems of older adults after twelve months in a single group pretest-posttest design, which limits the potential for causal inferences. Future studies should therefore also include a control group. Furthermore, our findings should be replicated while including robust older adults as the focus in this study was on those at risk of experiencing health-related problems, i.e. frail older adults and older adults with complex care needs. Also, this study should be replicated in other geographical areas, cultures and healthcare systems.

Conclusion

The most prevalent and most severe problems at baseline were related to Mental Functions and Mobility. The prevalence and severity of health-related problems decreased or remained stable in most clusters after receiving person-centred and integrated care for twelve months, except for Mobility-related problems, which showed a more varying pattern. These results are encouraging and may indicate that individual, person-centred and integrated care and support from Embrace offers a route to counteracting the decline in physical, cognitive and social functioning associated with ageing.

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Figures and Tables

Figure 1. Flowchart of participants

Table 1. Background characteristics of participants (n (%), unless stated otherwise)

Table 2. Items of the GeriatrICS grouped into clusters of health-related problems as experienced by community-dwelling frail older adults

Table 3. Baseline scores and change in prevalence and severity of health-related problems as assessed with the GeriatrICS after twelve months of person-centred and integrated care: results of the whole sample and per risk profile

Table 4. Baseline and change in prevalence and severity of health-related problems as assessed with the GeriatrICS after twelve months of person-centred and integrated care: results of participants with a problem at baseline, for the whole sample and per risk profile

Table 1. Background characteristics of participants

	Total (n=136)		Complex care needs (n=80)		Frail (n=56)		p
Age at T0 in years, median (IQR)	80.5	(78.1-84.8)	81.4	(78.9-85.4)	79.7	(77.2-82.8)	0.013
Female	94	(69.1)	54	(67.5)	40	(71.4)	0.707
Married/unmarried living together	65	(47.8)	42	(52.5)	23	(41.1)	0.224
Community-living	133	(97.8)	77	(96.3)	56	(100.0)	0.268
Low education level[1]	81	(59.6)	48	(60.0)	33	(58.9)	1.000
Low income[2]	61	(54.0)	34	(51.5)	27	(57.4)	0.570
No. of chronic conditions, mean (SD)	3.4	(1.7)	3.6	(1.6)	3.1	(1.8)	0.099
Multiple chronic conditions	58	(42.6)	43	(53.8)	15	(26.8)	0.003
Use of ≥4 different medications	105	(77.2)	66	(82.5)	39	(69.6)	0.098
INTERMED-E-SA, median (IQR)	16.0	(12.0-20.0)	19.0	(17.0-21.8)	12.0	(10.3-14.0)	<0.001
GFI, median (IQR)	6.0	(5.0-8.0)	7.0	(5.0-8.0)	6.0	(5.0-7.0)	0.244
Health status (EQ-5D-3L), median (IQR)	0.69	(0.65-0.78)	0.69	(0.65-0.78)	0.73	(0.65-0.81)	0.028
Health status (EQ-VAS), median (IQR)	65.0	(50.0-70.0)	60.0	(50.0-70.0)	70.0	(65.0-80.0)	<0.001
QOL report mark, mean (SD)	6.7	(1.2)	6.4	(1.2)	7.2	(0.9)	<0.001
ADL (Katz-15), median (IQR)	2.0	(1.0-4.0)	3.0	(1.3-5.0)	1.0	(0.0-3.0)	<0.001

ADL = Activities of daily living; EQ-5D-3L = EuroQol-5D-3L; EQ-VAS = EuroQol-5D visual analogue scale; GFI = Groningen Frailty Indicator; INTERMED-E-SA = INTERMED for the Elderly Self-Assessment; IQR = Interquartile range; QOL= Quality of life.

[1] Low: (Less than) primary school or low vocational training

[2] Low: <€1350 per month

Numbers, followed by percentages between brackets, are presented – unless stated otherwise.

Differences between risk profiles were tested using independent t-tests for continuous variables, Chi-square tests for categorical variables, and Mann-Whitney U tests for non-normally distributed continuous variables and ordinal variables.

Table 2. Items of the GeriatrICS grouped into clusters of health-related problems as experienced by community-dwelling frail older adults

Cluster	GeriatrICS item (ICF category)
Mental Functions	b144 Memory functions
	b152 Emotional functions
Physical Health	b210 Seeing functions
	b230 Hearing functions
	b410 Heart functions
	b420 Blood pressure functions
	b525 Defecation functions
	b620 Urination functions
	b810 Protective functions of the skin
Mobility	b240 Sensations associated with hearing and vestibular function
	b455 Exercise tolerance functions
	b710 Mobility of joint functions
	b730 Muscle power functions
	d410 Changing basic body position
	d450 Walking
	d470 Using transportation
Personal Care	d510 Washing oneself
	d520 Caring for body parts
	d540 Dressing
Nutrition	b530 Weight maintenance functions
	d550 Eating
	d560 Drinking
Support	d760 Family relationships
	e310 Immediate family
	e320 Friends
	e325 Acquaintances, peers colleagues, neighbours and community members
	e570 Social security services, systems and policies
	e575 General social support services, systems and policies
	e580 Health services, systems and policies

ICF=International Classification of Functioning, Disability and Health.

Table 3. Baseline scores and change in prevalence and severity of health-related problems after twelve months of person-centred and integrated care: results of the whole sample and per risk profile as assessed with the GeriatrICS

	Prevalence of health-related problems												Severity of health-related problems											
	Whole sample (n=136)				Older adults with complex care needs (n=80)				Frail older adults (n=56)				Whole sample (n=136)				Older adults with complex care needs (n=80)				Frail older adults (n=56)			
	T0 (%)	Δ (%)	P	ES	T0 (%)	Δ (%)	P	ES	T0 (%)	Δ (%)	P	ES	T0	Δ	p	ES	T0	Δ	p	ES	T0	Δ	p	ES
Mental Functions																								
b144 Memory functions	41.2	1.5	0.877	0.05	35.0	8.8↑	0.248	0.29	50.0	-8.9↓	0.302	0.38	1.4	-0.3↓↓	0.042	0.25	1.1	0.0	0.743	0.05	1.9*	-0.7↓↓	0.011	0.49
b152 Emotional functions	73.1+	-11.2↓↓	0.025	0.45	75.0+	-11.3↓	0.124	0.38	70.4+	-11.1↓	0.146	0.61	3.1+	-0.8↓↓	<0.001	0.44	3.3+	-0.8↓↓	0.005	0.45	2.8+	-0.8↓↓	0.024	0.44
Physical Health																								
b210 Seeing functions	48.5	8.2↑	0.136	0.28	47.5	7.5↑	0.377	0.21	50.0	9.3↑	0.267	0.45	1.9	0.2	0.318	0.12	1.8	0.0	0.972	0.01	2.1+	0.5↑	0.101	0.32
b230 Hearing functions	50.0	3.7	0.522	0.14	43.8	3.8	0.690	0.13	59.3	3.7	0.791	0.16	1.9	-0.1	0.773	0.04	1.5	-0.1	0.762	0.05	2.4+*	0.0	0.836	0.04
b410 Heart functions	51.5	-5.2↓	0.310	0.22	55.0	0.0	1.000	0.00	46.3	-13.0↓	0.065	0.83	1.7	-0.3	0.186	0.16	1.7	-0.1	0.632	0.08	1.7	-0.5↓	0.095	0.33
b420 Blood pressure functions	44.8	0.0	1.000	0.00	51.3*	0.0	1.000	0.00	35.2	0.0	1.000	0.00	1.2	0.1	0.951	0.01	1.4	0.2	0.843	0.03	1.0	0.0	0.920	0.02
b525 Defecation functions	36.6	-3.0	0.626	0.12	40.0	2.5	0.850	0.08	31.5	3.7↑	0.754	0.22	1.4	-0.3	0.189	0.16	1.4	-0.2	0.733	0.05	1.4	-0.5↓	0.073	0.35
b620 Urination functions	50.4	-4.5	0.451	0.15	56.3	5.0	0.584	0.15	41.5	3.8	0.791	0.16	1.9	-0.4↓	0.105	0.20	2.1+	-0.5↓	0.155	0.23	1.6	-0.3	0.453	0.15
b810 Protective functions of the skin	47.4	-6.7↓	0.200	0.26	43.0	2.5	0.832	0.10	53.6	-12.5↓	0.143	0.48	1.7	-0.6↓↓	0.007	0.33	1.6	-0.5↓	0.134	0.24	2.0+	-0.7↓↓	0.008	0.52
Mobility																								
b240 Sensations associated with hearing and vestibular function	64.2+	-6.0	0.302	0.19	70.0+	1.3	1.000	0.04	55.6	-13.0↓	0.167	0.43	2.6+	-0.7↓↓	0.008	0.33	3.0$*	-0.8↓↓	0.039	0.33	2.0+	-0.6↓	0.088	0.33
b455 Exercise tolerance functions	64.2+	5.2↑	0.337	0.20	65.0+	10.0↑	0.152	0.38	63.0+	1.9	1.000	0.07	2.4+	0.1	0.774	0.04	2.2+	0.5↑	0.148	0.23	2.6+	-0.4↓	0.143	0.28
b710 Mobility of joint functions	74.4+	0.0	1.000	0.00	67.5+	5.0	0.541	0.19	84.9+	-7.5↓	0.424	0.32	3.5+	-0.6↓↓	0.004	0.36	3.2+	-0.4↓	0.099	0.26	3.9+	-0.9↓↓	0.011	0.51
b730 Muscle power functions	47.4	11.3↑↑	0.037	0.38	51.3	12.5↑	0.100	0.38	41.5	9.4↑	0.302	0.38	1.5	0.4	0.164	0.17	1.3	0.5	0.117	0.25	1.8	0.1	0.743	0.06
d410 Changing basic body position	56.3	0.7	1.000	0.03	58.2	1.3	1.000	0.05	53.6	0.0	1.000	0.00	2.1+	-0.2	0.344	0.12	2.2+	-0.5↓	0.196	0.21	2.0+	0.1	0.854	0.03
d450 Walking	62.7+	3.7	0.542	0.13	63.3+	3.8	0.664	0.16	61.8+	3.6	0.832	0.10	2.6+	-0.1	0.564	0.07	2.6+	-0.2	0.600	0.08	2.7+	0.0	0.821	0.04
d470 Using transportation	14.7	6.6↑	0.188	0.27	13.8	8.8↑	0.210	0.35	16.1	3.6	0.791	0.16	0.5	0.1	0.284	0.13	0.4	0.2↑	0.182	0.21	0.8	0.0	0.932	0.02
Personal Care																								
d510 Washing oneself	19.9	-0.7	1.000	0.03	26.3*	1.3	1.000	0.04	10.7	0.0	1.000	0.00	0.6	0.0	0.979	0.00	0.7*	0.1	0.879	0.02	0.4	-0.1	0.725	0.07
d520 Caring for body parts	16.2	2.2	0.735	0.09	22.5*	1.3	1.000	0.04	7.1	7.1↑	0.344	0.47	0.3	0.1	0.545	0.07	0.4*	0.2	0.333	0.15	0.3	-0.1	0.787	0.05
d540 Dressing	15.4	7.4↑	0.123	0.33	20.0	11.3↑	0.124	0.38	8.9	1.8	1.000	0.16	0.4	0.1	0.159	0.17	0.4	0.2↑	0.127	0.24	0.3	0.0	1.000	0.00

Table 3. Continued

	Prevalence of health-related problems												Severity of health-related problems											
	Whole sample (n=136)				Older adults with complex care needs (n=80)				Frail older adults (n=56)				Whole sample (n=136)				Older adults with complex care needs (n=80)				Frail older adults (n=56)			
	T0 (%)	Δ (%)	P	ES	T0 (%)	Δ (%)	P	ES	T0 (%)	Δ (%)	P	ES	T0	Δ	p	ES	T0	Δ	p	ES	T0	Δ	p	ES
Nutrition																								
b530 Weight maintenance functions	30.8	-0.8	1.000	0.02	27.5	0.0	1.000	0.00	35.8	1.9	1.000	0.07	1.0	-0.2	0.355	0.11	0.9	-0.3	0.452	0.12	1.1	-0.2	0.548	0.12
d550 Eating	11.8	-0.7	1.000	0.06	16.3	1.3	1.000	0.07	5.4	0.0	1.000	0.00	0.3	-0.1	0.283	0.13	0.5*	-0.2	0.262	0.18	0.1	0.0	1.000	0.00
d560 Drinking	22.1	-10.3↓↓	0.018	0.56	27.5	-11.3↓	0.078	0.51	14.3	-8.9↓	0.180	0.69	0.8	-0.5↓↓	0.002	0.38	0.9	-0.5↓↓	0.021	0.37	0.6	-0.5↓↓	0.035	0.41
Support																								
d760 Family relationships	22.1	0.0	1.000	0.00	18.8	3.8	0.664	0.16	26.8	-5.4↓	0.581	0.26	0.8	-0.2	0.317	0.12	0.6	0.0	0.946	0.01	1.0	-0.4↓	0.119	0.30
e310 Immediate family	16.2	2.2	0.728	0.10	17.5	6.3↑	0.405	0.24	14.3	3.6↑	0.754	0.22	0.5	0.0	0.573	0.07	0.5	0.1	0.928	0.01	0.4	-0.2	0.412	0.16
e320 Friends	27.2	-2.9	0.635	0.11	27.5	3.8	0.710	0.11	26.8	-12.5↓	0.065	0.83	0.8	-0.4↓↓	0.029	0.27	0.7	-0.2	0.394	0.14	1.0	-0.6↓↓	0.015	0.47
e325 Acquaintances, peers, colleagues, neighbours and community members	27.2	-3.7	0.472	0.18	31.3	0.0	1.000	0.00	21.4	-8.9↓	0.227	0.54	0.9	-0.3↓	0.099	0.20	0.8	-0.2	0.395	0.13	1.1	-0.5↓	0.106	0.31
e570 Social security services, systems and policies	15.4	-5.9↓	0.096	0.53	16.3	-8.8↓	0.118	0.56	14.3	1.8↑	1.000	0.38	0.5	-0.2	0.268	0.13	0.4	-0.2↓	0.154	0.23	0.7	-0.1	0.610	0.10
e575 General social support services, systems and policies	15.4	-8.8↓↓	0.031	0.55	16.3	-7.5↓	0.210	0.44	14.3	-10.7↓	0.109	0.77	0.6	-0.5↓↓	0.005	0.35	0.6	-0.4↓↓	0.035	0.34	0.7	-0.5↓	0.074	0.34
e580 Health services, systems and policies	21.3	-6.6↓	0.176	0.29	16.3	0.0	1.000	0.00	28.6	-16.1↓↓	0.035	0.77	0.8	-0.3	0.055	0.23	0.6	-0.2	0.513	0.10	1.0	-0.5↓↓	0.016	0.47

ES=Effect size *d,* thresholds <0.2 trivial, ≥0.2- 0.5 small, ≥0.5-0.8 medium, ≥0.8 large
T0=Baseline measurement
Δ=Change between baseline and follow-up measurements
* Significant difference ($p<0.05$) at baseline between participants with complex care needs and frail participants.
^ Change between baseline and follow-up measurements is statistically significant after Bonferroni correction.
Missing values ranged between 1 and 3 per item.

+	High prevalence ≥60.0%/high severity score at T0 ≥2.0
↓↓	Significant and clinically relevant decrease in prevalence/severity
↓	Non-significant, but clinically relevant decrease in prevalence/severity
↑↑	Significant and clinically relevant increase in prevalence/severity
↑	Non-significant, but clinically relevant increase in prevalence/severity

Table 4. Baseline and change in prevalence and severity of health-related problems after twelve months of person-centred and integrated care: results of participants with a problem at baseline, for the whole sample and per risk profile as assessed with the GeriatrICS

	Number of participants with a health-related problem at baseline[#]						**Severity of health-related problems**											
	Whole sample		Older adults with complex care needs		Frail older adults		Whole sample				Older adults with complex care needs				Frail older adults			
	T0 (n)	Δ (%)	T0 (n)	Δ (%)	T0 (n)	Δ (%)	T0	Δ	p	ES	T0	Δ	p	ES	T0	Δ	p	ES
Mental Functions																		
b144 Memory functions	56	-35.7	28	-35.7	28	-35.7	3.4	-1.4↓^	<0.001	0.96	3.1	-1.2↓^	0.001	0.96	3.8	-1.7↓^	0.001	0.98
b152 Emotional functions	98	-27.6	60	-30.0	38	-23.7	4.2+	-1.4↓^	<0.001	0.79	4.3+	-1.5↓^	<0.001	0.85	4.0+	-1.3↓	0.004	0.70
Physical Health																		
b210 Seeing functions	65	-26.2	38	-34.2	27	-14.8	3.9	-0.7↓	0.047	0.35	3.8	-1.2↓	0.011	0.61	4.1+	0.1	0.919	0.03
b230 Hearing functions	67	-26.9	35	-31.4	32	-18.8	3.7	-0.9↓	0.018	0.42	3.5	-1.1↓	0.040	0.51	4.0+	-0.5↓	0.202	0.32
b410 Heart functions	69	-30.4	44	-27.3	25	-36.0	3.4	-1.2↓^	<0.001	0.69	3.2	-1.1↓	0.002	0.68	3.7	-1.4↓	0.016	0.72
b420 Blood pressure functions	60	-38.3	41*	-36.6	19	-42.1	2.7	-0.9↓	0.002	0.58	2.6	-0.8↓	0.026	0.51	2.8	-1.2↓	0.035	0.73
b525 Defecation functions	49	-42.9	32	-46.9	17	-35.3	3.8	-1.8↓^	<0.001	0.82	3.4	-1.5↓	0.003	0.80	4.6+	-2.1↓↓	0.015	0.91
b620 Urination functions	67	-35.8	45	-37.8	22	-36.4	3.8	-1.6↓^	<0.001	0.76	3.8	-1.6↓^	<0.001	0.80	3.8	-1.6↓	0.038	0.66
b810 Protective functions of the skin	64	-37.5	34	-35.3	30	-40.0	3.7	-1.9↓^	<0.001	0.93	3.7	-1.9↓	0.004	0.75	3.7	-1.9↓^	<0.001	1.26
Mobility																		
b240 Sensations associated with hearing and vestibular function	86	-31.4	56	-25.0	30	-43.3	4.1+	-1.7↓^	<0.001	0.76	4.3+	-1.7↓^	<0.001	0.70	3.6	-1.7↓^	0.001	0.92
b455 Exercise tolerance functions	86	-18.6	52	-15.4	34	-23.5	3.7	-0.6↓	0.024	0.35	3.4	-0.1	0.579	0.11	4.2+	-1.3↓	0.003	0.78
b710 Mobility of joint functions	99	-21.2	54	-18.5	45	-20.0	4.7+	-1.3↓^	<0.001	0.75	4.7+	-1.4↓^	<0.001	0.79	2.4	-1.2↓	0.002	0.70
b730 Muscle power functions	63	-25.4	41	-24.4	22	-22.7	3.2	-0.9↓	0.003	0.54	2.6	-0.7↓	0.049	0.45	4.4+*	-1.3↓	0.028	0.70
d410 Changing basic body position	76	-23.7	46	-23.9	30	-23.3	3.7	-1.2↓^	0.001	0.56	3.7	-1.5↓	0.003	0.65	3.8	-0.7	0.148	0.38
d450 Walking	84	-21.4	50	-18.0	34	-29.4	4.2+	-1.2↓^	0.001	0.53	4.0+	-1.0↓	0.033	0.44	4.4+	-1.3↓	0.007	0.69
d470 Using transportation	20	-70.0↓↓	11	-72.7↓↓	9	-66.7↓	3.6	-2.4↓↓^	0.001	1.17	2.7	-1.9↓	0.025	1.09	4.7+	-2.8	0.017	1.36
Personal Care																		
d510 Washing oneself	27	-66.7↓	21*	-66.7↓	6	-66.7↓	2.9	-1.5↓	0.029	0.62	2.5	-1.2	0.131	0.48	4.2+	-2.5	0.068	1.24
d520 Caring for body parts	22	-72.7↓↓	18*	-72.2↓↓	4	-75.0↓↓	2.0	-1.4↓	0.003	1.02	1.6	-0.8↓	0.013	0.91	4.3+*	-3.8	0.066	1.71
d540 Dressing	21	-57.1↓	16	-56.3↓	5	-60.0↓	2.3	-1.4↓^	0.001	1.26	2.1	-1.4↓	0.002	1.30	3.0	-1.2	0.109	1.18
Nutrition																		
b530 Weight maintenance functions	41	-61.0↓	22	-72.7↓↓	19	-42.1	3.1	-2.0↓↓^	<0.001	1.07	3.2	-2.6↓↓^	<0.001	1.48	3.1	-1.3↓	0.044	0.69
d550 Eating	16	-62.5↓	13	-69.2↓	3	-33.3	2.6	-2.0↓↓^	0.001	1.45	2.9	-2.3↓↓^	0.001	1.62	1.3	-0.7	0.317	0.89
d560 Drinking	30	-70.0↓↓	22	-68.2↓	8	-87.5↓↓	3.6	-3.0↓↓^	<0.001	1.45	3.4	-2.6↓↓^	<0.001	1.40	4.1+	-3.9↓↓	0.012	1.63

Table 4. Continued

	Number of participants with a health-related problem at baseline[#]						Severity of health-related problems											
	Whole sample		Older adults with complex care needs		Frail older adults		Whole sample				Older adults with complex care needs				Frail older adults			
	T0 (n)	Δ (%)	T0 (n)	Δ (%)	T0 (n)	Δ (%)	T0	Δ	p	ES	T0	Δ	p	ES	T0	Δ	p	ES
Support																		
d760 Family relationships	30	-60.0↓	15	-60.0↓	15	-53.3↓	3.4	-2.4↓↓^	<0.001	1.43	3.0	-2.4↓↓^	0.001	1.45	3.8	-2.3↓↓^	0.001	1.45
e310 Immediate family	22	-72.7↓↓	14	-64.3↓	8	-75.0↓↓	2.8	-1.9↓^	<0.001	1.37	2.9	-1.9↓	0.002	1.43	2.8	-2.4↓↓	0.027	1.32
e320 Friends	37	-59.5↓	22	-59.1↓	15	-60.0↓	3.0	-2.3↓↓^	<0.001	1.31	2.5	-2.0↓↓^	<0.001	1.38	3.7	-2.5↓↓	0.004	1.26
e325 Acquaintances, peers, colleagues, neighbours and community members	37	-45.9	25	-40.0	12	-66.7↓	3.4	-2.1↓↓^	<0.001	0.89	2.7	-1.2↓	0.031	0.64	5.0+*	-3.8↓↓	0.005	1.41
e570 Social security services, systems and policies	21	-61.9↓	13	-84.6↓↓	8	-25.0	3.5	-1.6↓	0.048	0.64	2.7	-1.5↓	0.026	0.97	4.9+*	-1.4	0.344	0.49
e575 General social support services, systems and policies	21	-90.5↓↓	13	-84.6↓↓	8	-100.0↓↓	4.0+	-3.7↓↓^	<0.001	1.47	3.5	-3.1↓↓	0.003	1.41	4.6+	-4.6↓↓	0.012	1.63
e580 Health services, systems and policies	29	-75.9↓↓	13	-76.9↓↓	16	-75.0↓↓	3.7	-2.6↓↓^	<0.001	1.15	3.8	-3.2↓↓	0.008	1.21	3.6	-2.1↓↓	0.005	1.13

ES=Effect size *d,* thresholds <0.2 trivial, ≥0.2- 0.5 small, ≥0.5-0.8 medium, ≥0.8 large
T0=Baseline measurement
Δ=Change between baseline and follow-up measurements
[#] Testing the change in prevalence per ICF item could not be performed, given that at baseline (T0) 100% of the older adults had a health-related problem with that ICF item.
* Significant difference (p<0.05) between participants with complex care needs and frail participants.
^ Change between baseline and follow-up measurements is statistically significant after Bonferroni correction.
Missing values ranged between 1 and 2 per item.
+ High severity score at T0 ≥4.0
↓↓ Decrease in prevalence ≥-70% / significant and clinically relevant decrease in severity ≥2.0
↓ Decrease in prevalence -50% to -70% / significant and clinically relevant decrease in severity <2.0

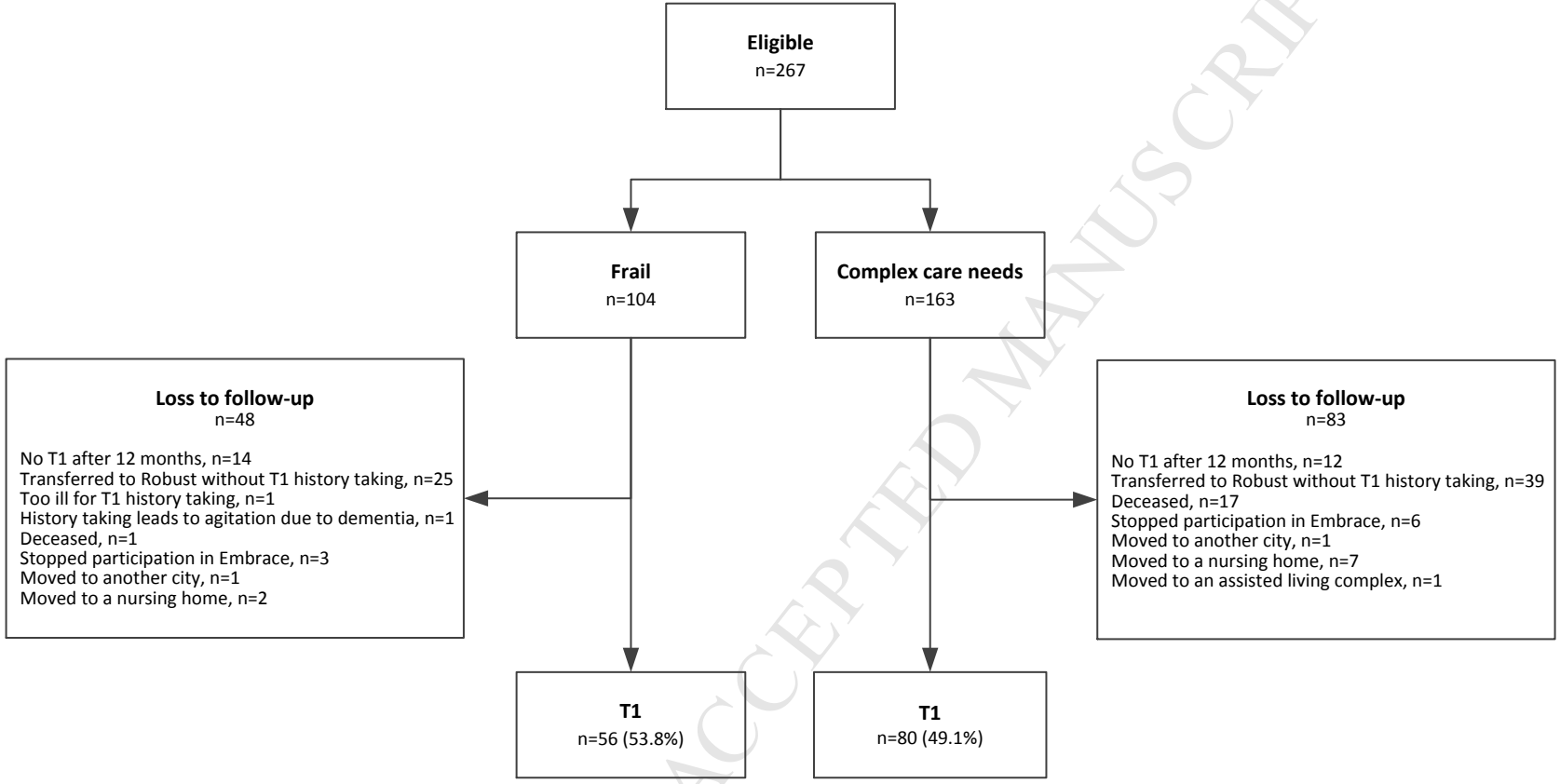

Figure 1. Flowchart of participants